TRANSPORT CHALLENGE IN 2020 – 2050

ECTRI POSITION PAPER

Research Needs in the Field of Transport Safety

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European Conference of Transport Research Institutes | ECTRI aisbl
Rue du Trône 98 | 1050 BRUSSELS | Belgium
Tel: + 32 (0)2 500 56 87/88
Number: 831 370 370
Website: **www.ectri.org**

Contact: Caroline Alméras, Secretary-General
E-mail: **caroline.almeras@ectri.org**

1. Introduction

ECTRI launched its Thematic Groups in September 2007 as a means to facilitate exchanges among its researchers interested in similar research fields and in order to promote joint initiatives and positions. The main objectives of these groups are to define research challenges of interest for supporting EC policies and programmes, to increase successful participation in EU projects and to provide a platform for networking and scientific exchanges. One of these groups is the Thematic Group on Safety (TG-Safety). The group consists of 29 experts from 20 Institutes and Universities representing 15 countries[1] . They represent the top European institutes in the field of transportation safety for all transport modes. This paper aims to present the research needs as identified by the group in the field of traffic safety for the horizon 2020-2050 to tackle the vision of a transport system which is safe for all its users, taking advantage of the radical progress of technology in the field, in a sustainable and economic way.

2. Research Needs for Safe Transportation

Transportation safety has been a major issue in research and policy making for decades. Significant progress has already been achieved at different levels, including number of fatalities and injuries, quality of the infrastructure, harmonization of regulations throughout the EU member states and – most notably – along the TEN-T network, etc. The introduction of new technologies in transportation, with electrification, digitalisation and automation being the ones with the most evident impact, has reformed the needs for research and innovation to adapt and foster their impacts towards the enhancement of transportation safety for all modes and considering all users.

The aim of this position paper is to highlight the current research needs in the field of transport safety, taking into account the emerging progress and the upcoming changes in the world of transportation. Of course, the needs are not limited to the ones annotated here

[1]

AIT	Austrian Institute of Technology	AT
BME	Budapest University of Technology and Economics	HU
CDV	Czech Transport Research Centre	CZ
DEUSTO	University of Deusto	ES
DLR	German Aerospace Center	DE
FhG	Fraunhofer Transport Alliance	DE
HIT	Hellenic Institute of Transport	EL
IFSTTAR	French Institute of Science and Technology for Transport, Development and Networks	FR
ITS	Motor Transport Institute	PL
KTI	Institute for Transport Sciences	HU
LNEC	National Laboratory for Civil Engineering	PT
TØI	Institute of Transport Economics	NO
TRL	Transport Research Laboratory	UK
TTI	Transport and Telecommunication Institute	LT
UNEW	Newcastle University	UK
UNIZA	University of Zilina	SI
UPM	Technical University of Madrid	ES
UVEG	University of Valencia	ES
VTI	Swedish National Road and Transport Research Institute	SE
VTT	Technical Research Centre	FI

and the dynamic nature of the transportation system and related progress are factors of constant modification. For this reason, the focus has been put on specific areas that were selected as the ones with the most prominent impact, addressing various modes and user groups.

3. Focus Areas

As already explained in the introduction, this position paper addresses all transport modes. Seven main focus areas have been selected, encompassing the needs for further research that would have a significant impact towards achieving the targets of the EU for transportation safety, as defined in the latest White Paper[2]. These areas are:

A. **Safety culture**
B. **Safe mobility for all**
C. **Automation & digitization safety implications**
D. **Evidence based policy making**
E. **Safety in intermodal/multimodal hubs**
F. **Safety in other modes (except road)**
    a. **Rail transport**
    b. **Maritime transport**
    c. **Air transport**

In the following sections, the current research needs for each of these areas are highlighted.

3.1. Safety Culture

Literature is broad about the importance of safety culture in preventing accidents, incidents, and near-misses. Still, safety culture remains a major factor to increase road safety as this approach helps understanding the usual patterns of risk perception and risk undertaking in transportation systems. Therefore, developing a strong safety culture aims to help reducing the number of accidents at local, regional, and national level, by adapting safety policies and changing behaviour and attitudes at individual and organizational/collective levels towards safety.

Research topics under this area revolve around how to ensure a high level of safety awareness in working places. Although safety culture or safety climate has been intensively studied in aviation or rail, for road as well as rail transport this is a topic that has rather recently been on focus. While lessons learned from other modes are useful and relevant solutions may be adapted also for road, the emerging evolution of road transport systems may result in raising issues that could not be covered by the existing risk reduction and/or risk management concepts. New issues need to be considered, bearing in mind that transportation systems are evolving towards automation and that new questions about safety already arise. In this context, new and emerging fields of mobility services, especially in the field of public transport and non-motorized transport have to be taken into account.

[2] WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system /* COM/2011/0144 final */

Moreover, special focus should be devoted on the introduction of new transport means, such as e-bikes, e-scooters and even the emerging urban air transport means. Some of them are already becoming a trend, others are upcoming. In all cases they are expected to have significant impact on safety culture and it is of utmost importance to establish training and awareness measures, in order to avoid negative impacts of their deployment

Safety Culture Priority Research Topics

a) ***Investigation of how automation can change safety issues for private actors in transportation (e.g. truck, bus or even car platooning).***
b) ***Investigation of the impacts on safety culture of new and emerging transportation means and their interaction with existing modes.***
c) ***Continuation of the investigation on the correlation between safety culture and number of accidents.***
d) ***Investigation of the effects on road safety of the implementation of ISO39001, the International Standard for Road Safety, or other Safety Management Systems (SMS).***
e) ***Investigation of the potential of adopting safety culture principles from aviation and rail to professional drivers on the road.***
f) ***Investigation on how to develop safety culture at an educational level.***

3.2. Safe Mobility for All

Mobility is a principle and a social right that has been highlighted in the last decades, both at research and implementation levels. The EU has established the “Design for all” principle for several applications, including traffic mobility, in order to provide systems and tools that would be easy to use and accessible for all citizens, regardless of their physical or other specific needs. Moreover, in the transport field, special focus has been dedicated to the needs of Vulnerable Road Users (VRUs), which include all user categories exposed to traffic and more vulnerable in case of their involvement in accidents (elderly, disabled, children, cyclists, pedestrians, etc.). The enhancement of VRU safety has become a greater priority, given the promotion of non-motorised transportation means, as well as in the framework of their interaction with new technological developments, such as electric and automated vehicles. This has led to the adoption of the new term “Non-Protected Users”, addressing also the concept of VRUs as non-connected traffic participants, which includes also occupants (passengers or drivers) of non-connected vehicles.

Safe Mobility for All Priority Research Topics

a) ***Level 4/5: ergonomics of crashes - “out of position” concept***
b) ***New types of VRUs (not connected users, e.g., drivers of conventional vehicles)***

3.3. Automation & Digitization Safety Implications

Connected and automated driving (CAD) is currently at the forefront of research, as the European Commission, OEMs and suppliers are eager to bring higher levels of automation on public roads. The introduction of automated vehicles of different levels of automation necessitates changes, adaptations and more research not only at technical level, but also at legal, policy and human factors level. The role of drivers is still highly relevant, whether

having an active involvement in the driving task (at SAE Level 2) or passive monitoring (SAE Level 3) for e.g. take-over requests, supervisory control of the automated driving system. The human task may also vary within one drive, as an automation system such as the Highway Pilot would perform the driving task only on motorways, requiring the driver to take back control when on urban roads (Level 4).

With regard to road safety, it is still not clear which effects automated vehicles can have and what types of new risks they may bring. The most evident safety risks come from a mixed road user population, namely traffic with both conventional and automated vehicles as well as VRUs. Issues related to the unexpected behaviour of (manual/automated) traffic participants, take-over requests and weather conditions are still subject to research. It has been found that drivers over-rely on automation systems to solve dangerous situations, have a tendency to engage in secondary tasks even when told that they should be monitoring the system and that drivers have a slow response to automation failures.

Although much effort has been put into solving the issues related to implementing connected and automated driving in road transport, there are open research questions especially with regard to the safety implications of automation (e.g., individual/societal acceptance, mixed traffic and penetration rates), big data and risk analyses (e.g., open access of data, validation of machine learning algorithms, adverse effects due to imbalanced learning data) and car-to-X communication and connectivity (e.g., consistent communication patterns in any environment). Questions also remain open regarding minimum infrastructure requirements for automated vehicles (on the open road as well as on bridges and in tunnels), adaptations to driver training, how to counteract driver de-skilling effects and the minimum capabilities a driver needs to operate an automated vehicle. Besides the vehicles themselves, the role of control centres for various forms of transportation becomes more and more important, especially with the vision of a driverless transportation system. Traffic management, disposition, (remote-)maintenance, the control of traffic hubs, and customer services are just examples for the tasks that will basically have to be addressed from a remote-control room in an appropriate manner. There will be a need to transfer best practices from aviation and railways e.g., in the fields of remote operation or transport planning to emerging services in public transport.

Automation & Digitization Safety Implications Priority Research Topics

a) Safety implications of automation

- **Ensure that humans can accept and use systems that enter the market.**
- **Standardized requirements for take-over requests (incl. in case of system failure) for human-machine interaction – resilient systems.**
- **Keeping the driver in the loop (for Level3 and partly Level 4 automation): monitoring of driver status and effective strategies for handover.**
- **Automated driving systems validation, homologation and type approval.**
- **De-skilling of novice drivers due to extended use of AD.**

b) Big data and risk analyses

- **Methods to avoid imbalanced learning sets & validation of machine learning algorithms.**
- **Testing and validation of machine learning methods**
- **Protection and storage of private data.**

c) Car2X Communication and connectivity

- **Defining cooperation in traffic and promoting it through innovative technologies.**

- **Standards for effective and efficient ways in which other traffic participants can communicate and exchange information with automated cars, e.g. pedestrians**
- **Development of a multi-brand Car2Car communication.**
- **Protection of Car2X communication – identification & mitigation of cybersecurity threats.**

d) Traffic management in automated public mobility services

- **New roles and tasks in control rooms**
- **Remote operations**
- **Remote interaction with passengers**
- **Remote maintenance**

3.4. Evidence Based Policy Making

Evidence-based policy making should help policy makers, service providers, and relevant stakeholders to make better decisions and achieve better outcomes. Therefore, the policy makers, service provides, and stakeholders should draw on the best available evidence from research and be aware of the consequences of their decisions and available options before making their decisions. There is, however, a need (a) to implement evidence-based policy-making schemes and (b) to systematically fill the knowledge map for the evidence-based policy-making scheme. Moreover, when developing/testing/piloting new solutions (especially considering AVs), objective evaluations are necessary. They should be independent (e.g., not done only by manufacturers themselves) and their results available, to enable validations, cross-comparisons, repeatability, etc. Only then the findings may create evidence, on which policy making could be based.

Evidence- Based Policy Making Priority research topics

a) Naturalistic driving/riding studies and effective analysis methods. Conditions and methodologies for reuse of past studies' data.

b) Smart cities integrated mobility applications

c) Major Europe-wide pilots in real conditions (multimodal, cross-border), related to:

- **Optimisation of technologies**
- **Key legal and operational issues to solve**
- **Awareness, acceptance, training and readiness enhancement of related stakeholders**
- **Enabling applications and tools (i.e. big data platforms and analytics development)**
- **Business scenarios build up and verification**

3.5. Safety in Intermodal/Multimodal Hubs and Crossings

Hubs are critical for the delivery of a range of desirable transport outcomes. For example, active travel and semi-active travel (e.g. electric scooters) will all require good quality hubs to enable access to rail and other onward shared mobility options. Furthermore, if we are to achieve modal shift away from cars for longer journeys then hubs and interchanges, with good access for cyclists, pedestrians and bus users, will be essential to provide competitive door to door travel times, comfort, safety and convenience.

Safety in intermodal/multimodal hubs & crossings Priority Research Topics

a) Rail crossings/ telematics interface between roads and rail

b) Lack of responsibility assignment for multimodal hubs' safety and security

c) ***Predictive maintenance of wagon and infrastructure and their subsystems.***
d) ***Perception of safety and security – implications for value of time and generalised travel costs***
e) ***Perception of time during interchange and its effect on travel behavior:how to influence it***
f) ***Facilities for active and semi-active travel objects – e.g. bikes, e-scooters***
g) ***Quality of information and its impact on journey plans***
h) ***Mode choice to get the hub and its impact on safety***

3.6. Safety in Other Transportation Modes (except road)

3.6.1. Rail Transport

It is envisaged that by 2050, rail transport in Europe would provide the backbone of an intermodal "Mobility as a Service" within cities and beyond, for both passengers and goods, meeting the needs of customers, EU citizens and society. A joint transport strategy to develop an integrated transport system that is more efficient, sustainable and centred around end-user needs is therefore essential. As well as striving to be a safe transport mode individually, the rail transport should also address safety at interfaces where it seamlessly links with other modes. Both active and passive safety should be considered. The two safety-critical emerging aspects for rail transport are introduction of autonomous vehicles and application of digital technology in controlling train signalling systems (and time tabling). The latter has seen a roll- out of the European Rail Traffic Management System (ETRMS) across Europe. When considering the rail safety credentials, safety must be addressed at all three levels namely station, platform train interface and the train (including its interaction with the rail infrastructure).

Human Factors in railway systems is a topic that is still underrepresented in research, compared to aviation and road transport. The emerging digitalization and automatization take away tasks from the operators, which switches their jobs to supervisory tasks for the most time. Next to its advantages, automatization poses huge challenges to the operator in the interaction with the system. Fatigue, vigilance, situation awareness and the operator's capability to detect and handle disruptions are topics that have to be taken into account in railway related research.

Rail Transport Safety Priority Research Topics

a) ***Remote diagnostics and maintenance of rail infrastructure along all routes and in any weather conditions.***
b) ***Resilience of rail in adverse climate conditions***
c) ***Railway operations in supervisory roles***
d) ***Human factors related activities***
e) ***Safety culture***

3.6.2. Maritime Transport

The safety of maritime transport has not been thoroughly investigated compared to other transport modes. For example, there is a lack of literature and praxis about the collection (reporting), standardization, accident analysis and valuation of injuries due to accidents. The

accidents can be personal injuries, fatalities as well as property damages, e.g., vessel, cargo. The vessels and cargo can be of different types which also can impact the safety outcome. Types of vessel damages are collision, fire, explosion, grounding, hard weather, engine failure. Types vessels are fishing boats, passenger ships, tank ships, and container ships. A dimension that makes maritime transport different compared to other transport modes is spills of fuel or chemicals into the water. This type of accidents can have a tremendous impact to the environment. It is also important to highlight that maritime transport can and should compete with other transport modes such as road and rail transport. Therefore, it is important to develop tools that can make possible comparisons to the road and rail transport[3].

Maritime Transport

a) ***Autonomous ships/barges***
b) ***Electric (short sea shipping) – other fuels (e.g. hydrogen, NLG) for longer routes – impact on safety in case of accidents.***
c) ***Standardized and better collection and classification of person injuries and fatalities as well as vessel damages per type, across EU members.***
d) ***Investigation of the accident risk for persons, vessels, and fuel spills.***
e) ***Investigation of impact of delayed arrivals and cargo damages.***
f) ***Investigation of route optimization as well as port and bridge designs.***
g) ***Accidents' internalisation studies***
h) ***Piracy issues – protection of ships, including autonomous ones***
i) ***Safety in automated docks and ports***

3.6.3. Air Transport

International and domestic passenger transport by fixed wing aircraft has an excellent safety record, both within EU and other developed countries. This does not necessarily mean that current and future systems are safe, and researchers point increasingly to new safety and security threats, many of which may go undetected as we strive to maintain our understanding of how components interact in systems rapidly increasing in socio-technological complexity. Technological development has led also to direct threats to international flight safety, such as the use of lasers or drones to disrupt airport activities, or those related to cyber-security. While already advanced, internationalisation of air transport continues apace, and challenges remain, particularly as competitiveness is increased through globalisation, e.g. single airlines are using crews based in different countries, with varying work conditions, cultures and safety practices. EU regulation on pilot flight time limitations (FTL) remains controversial and flight data systems can also be harnessed for improved monitoring of pilot fatigue, giving improved feedback to pilots and managers. Collection of flight data across airlines might provide a basis for improved FTL regulation.

As air traffic increases in EU airspace, big data and increased connectivity in the air sector will be important to improve our understanding of safer interactions in the skies and around major airports and hubs. This will become more important as short intercity air transport and even intracity transport becomes more popular.

[3] Vierth, I., Landergren, M., & Sowa, V. (2016). Svenska sjöolyckors samhällsekonomiska kostnader. Värdering av fartygsskador, oljeutsläpp och personskador. VTI Notat 32-2015. In Swedish with English Summary

There is a need for increased flight safety for domestic helicopter and light fixed wing flights, particularly in private operations, and to assess the role of operating organisations and training practices in these areas.

There is an urgent need for regulation to progress for the use of Vertical Take-off and Landing aircraft and drones by private and industrial actors – both for the transport of passengers and goods. Development of the role of drones is also needed to improve the safety and security in the air and other sectors (e.g. emergency organ transport in the health sector, rail maintenance, investigation of tunnel incidents etc.). Models of how we safely use the airspace surrounding our major cities, which is becoming increasingly congested by more diverse and technologically advanced aircraft, are also urgently needed.

Based on these considerations, we highlight the following topics as those that should be prioritised for research funding.

Air Transport

a) ***Integration of "new safety thinking" (better suited to understand complex, intractable sociotechnical systems) into existing safety practice is required, to both improve system resilience and support moves towards SMS for whole ecosystems in air transport.***
b) ***Air safety issues for short intercity air transport (using extended air fields)***
c) ***Air safety issues of drones (BVLS) and air urban transport vehicles (i.e. vertically taking off and landing vehicles-VTOLs).***
d) ***Use of big data to improve flight safety and the threats of using big data.***

4. Recommendations for Horizon Europe / other calls

To extend and maximise the success of Horizon Europe Framework Programme, ECTRI recommends to:

- **Add a clear budget breakdown, defining priorities and budget within the clusters**
- **Maintain proper balance within the research and innovation chain**
- **Add clear references to well accepted EU strategies**
- **Develop a clear definition of missions**
- **Assure establishment and continuation of PPPs for dedicated topics**
- **Balance safety vs mobility**

For cluster 4 "Climate, Energy and Mobility", ECTRI recommends that:

- **The cluster also targets SDG 9 (Industry, Innovation and Infrastructure)**
- **Sustainable cities and mobility are given a more profound role in the future programme**
- **Effort in understanding the human factors to support behaviour change is reinforced**
- **The role of traffic safety and its prominence is strengthened within the cluster as well as the resilience of transport systems**
- **Logistics, and more generally the mobility of goods, is given a better focus.**
- **Safety related resources as priority to be as high as energy efficiency and environmental protection (3 pillars for cluster 4)**